

AD-A130 066 CONCEPTS EVALUATION MODEL (CEM) ATTRITION AND
CALIBRATION MODIFICATION II. (U) GENERAL RESEARCH CORP
UNCLASSIFIED MCLEAN VA EASTERN TECHNOLOGIES DIV W T ALLISON JUN 81
GRC-1162-02-81-CR MDA903-80-C-0321 F/G 14/2

CONCEPTS EVALUATION MODEL (CEM) ATTRITION AND
CALIBRATION MODIFICATION II..(U) GENERAL RESEARCH CORP
MCLEAN VA EASTERN TECHNOLOGIES DIV W T ALLISON JUN 81
GRC-1162-02-81-CR MDA903-80-C-0321 F/G 14/2

1 / 1

UNCLASSIFIED

F/G 14/2

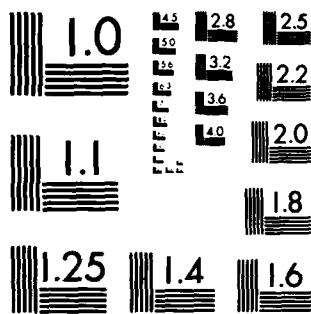
NL

END

DATE _____

8 83

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

1162-02-81-CR

**Concepts Evaluation Model (CEM)
Attrition and Calibration Modification II**

FINAL REPORT

By:

William T. Allison

June 1981

EASTERN TECHNOLOGIES DIVISION

**GENERAL
RESEARCH**



CORPORATION

A SUBSIDIARY OF FLOW GENERAL INC.

7655 Old Springhouse Road, McLean, Virginia 22102

**DTIC
ELECTE
JUL 6 1983
S A D**

Submitted To:

**Mr. Philip E. Louer
Director, MCD**

**U.S. Army Concepts Analysis Agency
Bethesda, Maryland 20014**

Contract MDA903-80-C-0321

**This document has been approved
for public release and sale; its
distribution is unlimited.**

83 07 - 06 093

AD A1 30066

DTIC FILE COPY

The views, opinions, and findings contained in this report are those of the author(s) and should not be construed as an official Department of Defense position, policy, or decision, unless so designated by other official documentation.

1162-02-81-CR

Concepts Evaluation Model (CEM) Attrition and Calibration Modification II

FINAL REPORT

By:

William T. Allison

June 1981

EASTERN TECHNOLOGIES DIVISION

**GENERAL
RESEARCH**  **CORPORATION**

A SUBSIDIARY OF FLOW GENERAL INC.

7655 Old Springhouse Road, McLean, Virginia 22102

Submitted To:

Mr. Philip E. Louer
Director, MCD
U.S. Army Concepts Analysis Agency
Bethesda, Maryland 20014

Contract MDA903-80-C-0321

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 1162-02-81-CR	2. GOVT ACCESSION NO. AD-A130066	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) CONCEPTS EVALUATION MODEL (CEM) ATTRITION AND CALIBRATION MODIFICATION II		5. TYPE OF REPORT & PERIOD COVERED Final Report 9/23/80 - 6/4/81
7. AUTHOR(s) William T. Allison		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Eastern Technologies Div., General Research 7655 Old Springhouse Road McLean, Virginia 22102		8. CONTRACT OR GRANT NUMBER(s) MDA903-80-C-0321
11. CONTROLLING OFFICE NAME AND ADDRESS CSCA-MR 8120 Woodmont Avenue Bethesda, Md. 20014		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Mr. P. E. Louer Director, MRCD US Army Concepts Analysis Agency Bethesda, Md. 20014		12. REPORT DATE June 1981
		13. NUMBER OF PAGES 37
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of this Report)		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Combat simulation, model calibration, combat attrition, CEM		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Calibration of the CEM theater combat model attrition calculations against that of a high-resolution model.		

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

CONTENTS

<u>SECTION</u>		<u>PAGE</u>
1	BACKGROUND	1
2	SPECIFIC TASKS	2
3	CEM MODIFICATIONS	3
	3.1 Overview	3
	3.2 Preprocessor	3
	3.3 Main Model	5
4	SUMMARY COMMENTS	10
	4.1 Limitations and Constraints	10
	4.2 Engagement Results	10
<u>APPENDIX</u>		
A	NEW AND/OR MODIFIED VARIABLE AND ARRAY DEFINITIONS	A-1
B	MODIFIED CARD INPUT FORMATS	B-1
C	SAMPLE OUTPUT FROM A CEM BATTLE ENGAGEMENT	C-1

CONCEPTS EVALUATION MODEL (CEM)
ATTRITION AND CALIBRATION MODIFICATION II

1 BACKGROUND

In the fall of 1979, General Research Corporation (GRC) developed the specifications for a new combat attrition algorithm in the Concepts Evaluation Model (CEM).¹ This was followed in 1980 by the integration of the algorithm into the CEM for direct fire weapons and mortars.² The new attrition algorithm replaced the "firepower potential" as a basis for combat losses inflicted by weapons other than artillery and tactical aircraft.

The integration of the revised attrition calculation left the ~~CEM~~ with the following discrepancies:

1. Two separate attrition algorithms were required for the same engagement. The two calculations were independent and could result in overstating the combat losses.
2. Artillery firepower was equally distributed among all targets and an expected quantity of ammunition was expended regardless of availability of targets.

¹ John E. Shepherd, Concepts Evaluation Model (CEM) Design Specifications for: (1) Attrition and Calibration, (2) Fixed Fortified Defense, General Research Corporation, 1118-01-79-CR, 1979.

² John E. Shepherd, Concepts Evaluation Model (CEM) Attrition and Calibration Modification I, General Research Corporation, 1162-01-80-CR, 1980.

2 SPECIFIC TASKS

→ The objective of this study is to continue modifications to the CEM to eliminate dependence of artillery and tactical air weapons upon fire-power potential and integrate these weapons into the new attrition algorithm:

- a. In accordance with the design specifications, developed by Concepts Analysis Agency, develop new and modify existing CEM subroutines as required to incorporate artillery and air into the new attrition process.
- b. Develop a set of representative data inputs and conduct limited testing of the integrated process. ←

3 CEM MODIFICATIONS

3.1 OVERVIEW

Figure 1 shows the macro flow of the CEM for the new attrition algorithm. The use of firepower potentials for computation of combat losses is eliminated entirely. High resolution model results expressed in killer/victim scores and fire allocation will be used for ground weapons other than artillery. Lethal areas for artillery weapons against each target and average target density will be derived from the high resolution results. For the purposes of calculating attrition, close air support is treated in the same manner as artillery.

Firepower potentials will continue to be used in CEM for the estimate of the situation and decision making by the various echelons. They will also be required for assessing casualties suffered by reserve units.

The attrition algorithm requires data input from a high resolution model, shown in Fig. 1 as the Combat Sample Generation (COSAGE). These data are entered into a new preprocessor named PHASE 1 which computes target to weapon availability and probability of kill. These two arrays are then "passed" via a data file to the second new routine, PHASE 2, in CEM main. These two routines were developed during the initial modification for the direct fire weapon algorithm.

The constraints imposed by the CAA UNIVAC computer (addressable memory) required that the number of maneuver unit weapon types available to each side be limited to 12. Eight types of artillery tubes and a notional aircraft are allowed in both CEM and CEM/ATRIT, the modified CEM with the revised attrition algorithm.

3.2 PREPROCESSOR

This section describes the changes to each subroutine in the CEM preprocessor to accommodate the artillery attrition process. The subroutines described in this and the following paragraphs, and GRC Report 1162-01-80-CR, constitute the total modifications required in the preprocessor and main model

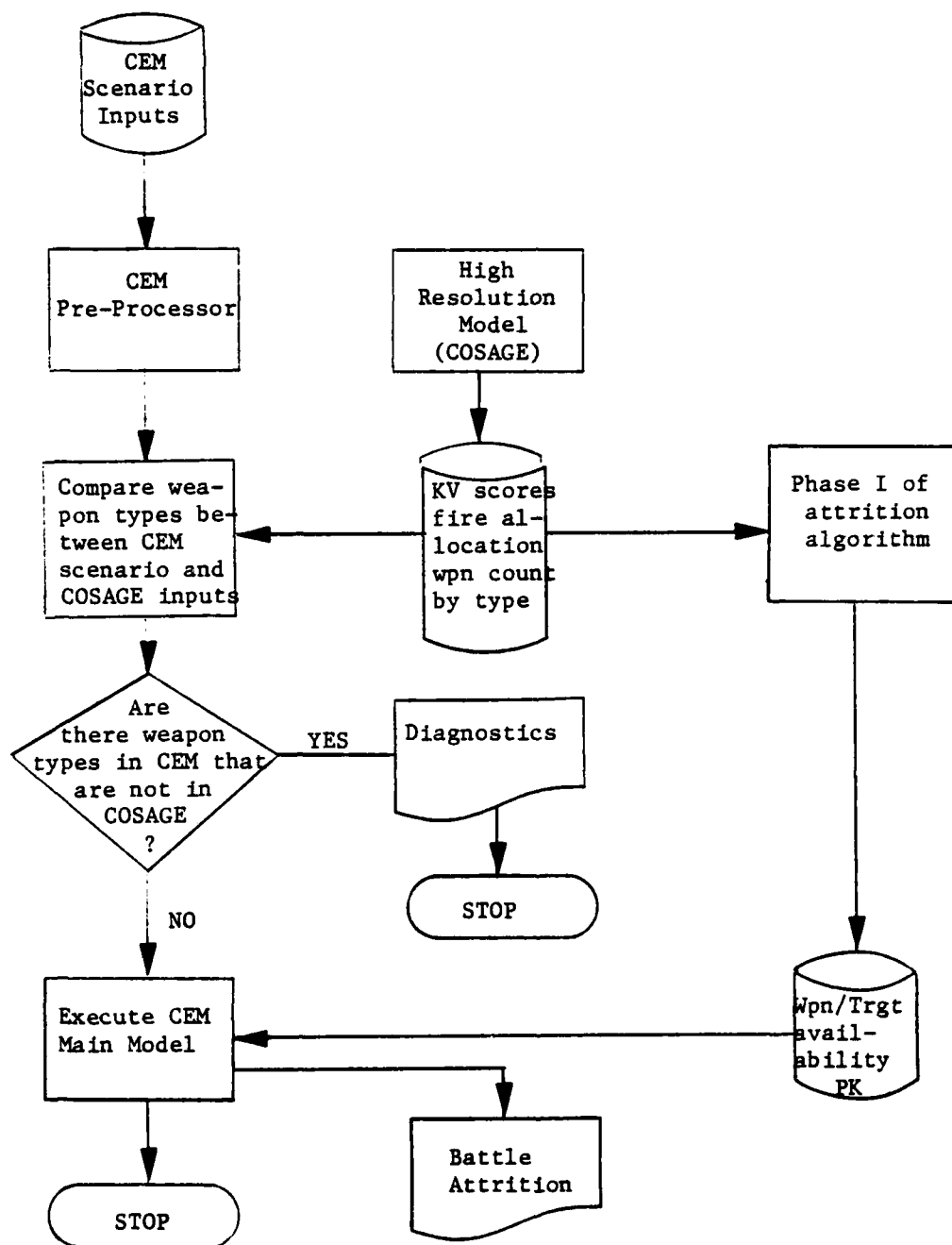


Figure 1. CEM MACRO Flow w/New Attrition Algorithm

to produce CEM/ATRIT. Subroutines modified are: UNTSEC, RDBDIV, and RDRDIV.

3.2.1 Subroutine: UNTSEC

This routine inputs the data describing each artillery tube and battalion type. Changes are:

- a. The array CANNON, containing data for each type of artillery tube, was redefined as (18,8,2)
- b. The array ARTBNT, which contains data items for each type of artillery battalion, was redefined as (15,15,2).
- c. The array ALNGS, which contains data for non-divisional General Support Artillery, was changed to (41,2).

3.2.2 Subroutine RDBDIV

This subroutine reads the BLUE Division data and establishes the divisional artillery status array ARTSTA for both Direct Support and General Support battalions. Changes were made to include the battalion authorized and on hand amount of ammunition by ammunition type (maximum of 2). This resulted in changing the size of the array ARTSTA to (16,530).

3.2.3 Subroutine RDRDIV

This subroutine reads the RED Division data and builds the RED divisional artillery status array ARTSTA. Changes were made to include the authorized and on hand of type 2 ammunition.

3.3 MAIN MODEL

The following section describes the changes required in subroutines of the CEM Main Model. Subroutines requiring modifications are:

ARTCAS	CRQMNT	QPMOD
ARTDEC	GIVART	RARTS
ASNAB	MATSUM	READAT
ASSESS	MYOUT	SUMART
CASL	NDSUPY	TNKAPC
CB	PHASE 2	

3.3.1 Subroutine ARTCAS

This subroutine proportions the artillery tube attrition and ammunition expenditures to each artillery battalion (Direct and General Support) as a function of the contribution from each battalion for the subsector engagement.

3.3.2 Subroutine ARTDEC

This routine decrements the artillery status files by the tube attrition and ammunition expended by a unit. The addition of a second type of artillery ammunition required expanding the size of the status files and the array RQMNTS.

3.3.3 Subroutine ASNRAB

This routine adds reinforcing artillery battalions to the non-divisional artillery status file. The introduction of a second ammunition type necessitated enlargement of the status file and shifting location of the data elements.

3.3.4 Subroutine ASSESS

This subroutine controls the combat assessment phase of CEM.
Changes are:

- a. Increase size of RQMNTS and RQMNTX arrays to accommodate second artillery ammunition type and initialize the arrays.
- b. Convert close air support aircraft losses due to maneuver battalion weapons to squadrons and include with squadron losses due to divisional air defense weapons.

3.3.5 Subroutine CASL

This subroutine controls the computation of damaged weapons totally destroyed, reparable, and abandoned. The changes required are:

- a. Expanding the weapons and associated arrays used in computing attrition and expenditures to accommodate the 8 types of artillery tubes plus tactical air.

- b. Eliminate calculating the loss of personnel and anti-tank/mortar weapons due to artillery and CAS.

3.3.6 Subroutine CB

This subroutine was rewritten to eliminate counter battery fire and effects of artillery suppression. Losses of artillery weapons and personnel and expenditure of ammunition is now calculated in the attrition subroutine PHASE 2. The number of artillery tubes by type used in the engagement from each artillery battalion is determined in this routine.

3.3.7 Subroutine CROMNT

This subroutine sums the requirements of each unit and the theater requirements for personnel, supplies, and equipment. The changes are:

- a. Increase the size of the RQMNTS array to include artillery ammunition type 2.
- b. Increase the size of the RQMNTX array to include artillery ammunition type 2 for each BLUE partition.

3.3.8 Subroutine GIVART

This subroutine resupplies personnel, ammunition and cannons to divisional artillery battalions. The change is to replenish two types of artillery ammunition in each battalion's status file.

3.3.9 Subroutine MATSUM

This subroutine determines the number of effective direct support artillery battalions in an engagement by degrading the total number by the number which are ineffective due to deficiencies in communications and control. The fire power matrix for an estimated engagement is formed in MATSUM. The changes are:

- a. Including CAS squadrons along with artillery battalions to determine effective battalions and squadrons.
- b. Eliminating the calculation of firepower scores for artillery and CAS to be used during the assessment of combat casualties. All combat casualties to FEBA units are determined in PHASE 2.

3.3.10 Subroutine MYOUT

This subroutine determines the outcome of an engagement. The change is to eliminate outcome determination for the assessment phase. The expected outcome for the estimation phase is based on force ratio from the firepower potential matrices.

3.3.11 Subroutine NDSUPY

This subroutine resupplies personnel, ammunition, and cannons to the non-divisional artillery battalions. The change is to resupply two types of ammunition to the non-divisional artillery status file.

3.3.12 Subroutine PHASE 2

This subroutine calculates personnel and equipment losses, ammunition expenditures, and force ratio for an engagement. The change incorporates artillery and close air support weapons into the attrition calculations.

3.3.13 Subroutine QPMOD

This subroutine calculates the extent of weapon effectiveness degradation due to a shortage of cannoners in an artillery battalion. The change is to eliminate determination of the effects of ammunition shortages.

3.3.14 Subroutine RARTS

This subroutine computes the resupply requirements for artillery. The change redesignates the subscripts in the divisional and non-divisional artillery status files and the theater requirements array due to the inclusion of a second artillery ammunition type.

3.3.15 Subroutine READAT

This routine inputs data from the CEM preprocessor and Phase 1 of the attrition algorithm to the main model. The changes are:

- a. To input the lethality of an artillery weapon against each type of target.

- b. To compute the sum of the probability of kill for a weapon against each target. This sum is used in the attrition phase to determine priority of targets for a weapon.

3.3.16 Subroutine SUMART

This subroutine sums the artillery battalion requirements for re-supply. The changes are to provide proper subscripts for the artillery status file and the requirements array.

3.3.17 Subroutine TNKAPC

This routine calculates the number of weapons systems reparable (given the hits from PHASE 2), breakdowns and vehicles abandoned for an engagement. The change eliminated the calculation of weapons damaged by artillery and close air support by the use of firepower potential.

4 SUMMARY COMMENTS

4.1 LIMITATIONS AND CONSTRAINTS

This study was limited in the number of weapons available to both RED and BLUE in an engagement and used high resolution results for only one engagement type (posture) to determine the inputs required in the CEM attrition phase. These limitations were imposed due to:

- a. Availability of computer memory at the onset of the study.
- b. Availability of computer memory to support probability of kill arrays for the full scope of postures portrayed in CEM.
- c. Uncertainty of the algorithm to support attrition suffered by units in reserve.

During the implementation of the new attrition process for direct fire weapons, the constraints imposed by the CAA UNIVAC 1108 computer (available memory) required reducing the number of direct fire weapon types available to each side from 41 to 12. The acquisition of the UNIVAC 1100/82 by CAA has relieved this constraint for a single killer victim scoreboard and the main model has been changed to accept the full complement of weapon types.

4.2 ENGAGEMENT RESULTS

A typical engagement result is shown in Appendix C. The quantities shown in the column entitled "Rounds/wpn/tube Allowable" represent the input firing rate or stowed load for the weapon types, while the on-hand represents the maximum of the stowed load quantity or the actual amount available for this engagement.

The total ammunition expended by direct fire weapons (wpn type 1-13) is controlled by the probabilities of kill and target mix. Thus, the amount expended, in most cases, is below the allowable expenditure. This is not the case for indirect fire (wpn types 14-22). The expenditure for these weapons is controlled only by:

- a. The on hand quantity
- b. The average number of weapons remaining.

An example of the above is BLUE weapon type 22. This weapon type expended a total of 14,682.66 rounds of a possible 14,890 (500 rounds allowable x 29.78 weapons at the start of the engagement). The difference is accounted for by the number hit which reduces the number available to fire.

Sensitivity of the engagement results to data input was not conducted during this project. However, it appears that the amount of artillery ammunition expended during a campaign will be highly dependent on the stowed load input quantity. Special care may be required in developing these inputs to avoid biasing the capability of artillery.

Appendix A

NEW AND/OR MODIFIED VARIABLE AND ARRAY DEFINITIONS

<u>Variable</u>	<u>Page</u>
ALNGS	A-2
AMOPRS	A-3
ARTBNT	A-4
ARTSTA	A-5
CANNON	A-6
RQMNTS	A-7
RQMNTX	A-8
EXPART	A-9
TTLART	A-10
TUBQNT	A-11
YARTY	A-12
AMMO	A-13
SUMWPN	A-14
AMOSTO	A-15
P	A-16
CONAMO	A-17
LETH	A-18

1. Variable Name: ALNGS (i, j)

Size: (41, 2)

2. Array Specification:

a. General Description and Usage: The array ALNGS contains complete information for non-divisional GS artillery. Reinforcing artillery is added to this array and distributed from theater down to Brigade/Division. It is referenced in the estimation, assessment, and resupply phases of CEM.

b. Data Entry Definitions:

i = (1-2) Authorized and on hand personnel
 (3-4) Authorized and on hand type 1 ammo
 (5-6) Authorized and on hand type 2 ammo
 (7-8) Authorized and on hand tube type 1
 (9-10) Authorized and on hand tube type 2
 .
 .
 .
 .
 (21-22) Authorized and on hand tube type 8
 (23) Quantity non-divisional GS battalions in theater
 (24-25) Authorized and on hand personnel BLUE partition 1
 (26-27) Authorized and on hand type 1 ammo, BLUE partition 1
 (28-29) Authorized and on hand type 2 ammo, BLUE partition 1
 .
 .
 .
 .
 (40-41) Authorized and on hand type 2 ammo, BLUE partition 3
j = (1-2) Side

1. Variable Name: AMOPRS (i, j)

Size: (3, 9)

2. Array Specifications:

a. General Description and Usage: The array AMOPRS contains the number of cannoneers and ammunition, by type, for each artillery unit in the engagement. The value is computed in CB.

b. Data Entry Definition:

i = (1-3) Number of cannoneers, ammo type 1, and ammo type 2

j = (1-9) Artillery unit (1 = BLUE Brigade DS; 2 = Reserve BLUE Brigade DS; 3 = BLUE Division GS; 4 = RED DS; 5 = RED division GS; 6 = BLUE non-division GS; 7 RED non-division GS) and total (8 = BLUE; 9 = RED).

1. Variable Name: ARTBNT (i, j, k)

Size: (15, 15, 2)

2. Array Specifications:

a. General description and Usage: The ARTBNT array contains descriptors for each type artillery battalion. It is used to build the non-divisional artillery status file.

b. Data Entry Definitions:

- i = (1) Number of personnel authorized in the battalion
- (2) Number of personnel on hand
- (3) Authorized amount of type 1 ammo
- (4) On hand amount of type 1 ammo
- (5) Authorized amount of type 2 ammo
- (6) On hand amount of type 2 ammo
- (7) Tube type x authorized
- (8) Tube type y authorized
- (9) Tube type z authorized
- (10-11) Quantity authorized and on hand of tube type x
- (12-13) Quantity authorized and on hand of tube type y
- (14-15) Quantity authorized and on hand of tube type z
- j = (1-15) Battalion type
- k = (1-2) Side

1. Variable Name: ARTSTA (i, j)

Size: (16,530)

2. Array Specifications:

a. General Description and Usage: The array ARTSTA contains information for the divisional General Support and Direct Support artillery. It is used in assessment and resupply phases.

b. Data Entry Definitions:

i = (1-2) Number of personnel authorized and on hand
 (3-4) Authorized and on hand of type 1 ammo
 (5-6) Authorized and on hand of type 2 ammo
 (7-9) Tube type x, y, z authorized
 (10-11) Authorized and on hand of tube type x
 (12-13) Authorized and on hand of tube type y
 (14-15) Authorized and on hand of tube type z
 (16) Artillery battalion type

j = (1) BLUE Division 1 GS artillery index
 (2) BLUE Division 1, Brigade 1 DS arty index
 (3) BLUE Division 1, Brigade 2 DS arty index
 (4) BLUE Division 1, Brigade 3 DS arty index
 .
 .
 .
 (280) BLUE Division 70, Brigade 3 DS arty index
 (281) RED Division 1 GS arty index
 (282) RED Division 1 DS arty index
 .
 .
 .
 (529) RED Division 125 GS arty index
 (530) RED Division 125 DS arty index

1. Variable Name: CANNON (i, j, k)

Size: (18,8,2)

2. Array Specification

a. General Description and Usage: The CANNON array contains attribute data for each type of artillery tube. It is used in assessment to determine the effects of a personnel shortage and the firepower scores against reserve units.

b. Data Entry Definitions:

- i = (1) Personnel per tube
- (2) Breakdown rate per division cycle
- (3) Fraction of authorized crew below which tube is not effective (R constraint)
- (4) Fraction of authorized crew below which tube becomes less than 100% effective (Q constraint)
- (5-6) Meeting engagement AT IFP for ammo types 1 and 2
- (7-8) Meeting engagement ALA IFP for ammo types 1 and 2
- (9-10) Meeting engagement AP IFP for ammo types 1 and 2
- (11) Stowed load, type 1 ammo
- (12) Stowed load, type 2 ammo
- (13-15) AT, ALA, AP IFP against reserve targets
- (16) Ammo type 1 expended against reserve targets
- (17) Ammo type 2 expended against reserve targets
- (18) Multiplier for increased DS artillery firing rate.

j = (1-8) Cannon type

k = (1-2) Side

1. Variable Name: RQMNTS (i, j)

Size: (56,2)

2. Array Specifications

a. General Description and Usage: The array RQMNTS contains the theater requirements for all items of equipment and supplies. Requirements are computed during assessment and used in resupply phase of CEM.

b. Data Entry Definition:

i = (1) Personnel requirement
(2) POL requirement
(3) Maneuver unit type 1 ammo requirement
(4) Maneuver unit type 2 ammo requirement
(5) Other supply requirement
(6-17) Tank requirements types 1-12
(18-29) Light armor requirements types 1-12
(30-34) Helicopter requirements types 1-5
(35-46) AT/M requirements types 1-12
(47-54) Artillery tube requirements types 1-8
(55) Artillery type 1 ammo requirement
(56) Artillery type 2 ammo requirement

j = (1-2) Side

1. Variable Name: RQMNTX (i, j)
Size: (7, 3)

2. Array Specifications:

a. General Description and Usage: The array RQMNTX is the total requirement for personnel and supplies for each BLUE partition. Requirements are calculated during the assessment phase and are used in the re-supply phase.

b. Data Entry Definitions:

i = (1)	Personnel
(2)	POL
(3)	Type 1 maneuver unit ammo
(4)	Type 2 maneuver unit ammo
(5)	Other supplies
(6)	Type 1 artillery ammo
(7)	Type 2 artillery ammo

1. Variable Name: EXPART (i, j, k)

Size: (11, 4, 2)

2. Array Specifications:

a. General Description of Usage: The array EXPART contains the artillery unit losses due to combat.

b. Data Entry Definitions:

- i = (1) Personnel losses
- (2) Type 1 ammo expended
- (3) Type 2 ammo expended
- (4-11) Artillery tube losses, types 1-8
- j = (1) On line BLUE brigade/RED division DS arty bn
- (2) BLUE reserve brigade DS bn
- (3) Division GS bn
- (4) Non-divisional GS bn
- k = (1-2) Side

1. Variable Name: TTLART (i, j)

Size: (11, 2)

2. Array Specifications:

a. General Description and Usage: The array TTLART contains the theater wide artillery losses.

b. Data Entry Definitions:

i = (1)	Personnel
(2)	Type 1 artillery ammo
(3)	Type 2 artillery ammo
(4-11)	Artillery tubes, types 1-8
j = (1-2)	Side

1. Variable Name: TUBQNT (i, j)
Size: (8, 9)

2. Array Specifications

a. General Description and Usage: The array TUBQNT contains the number of artillery tubes by type in each engagement.

b. Data Entry Definitions:

i = (1-8) Quantity of artillery tubes types 1-8

j = (1) On line BLUE brigade DS artillery bn
(2) BLUE reserve brigade DS artillery bn
(3) BLUE division GS bn
(4) RED division DS bn
(5) RED division GS bn
(6) BLUE non-divisional GS bn
(7) RED non-division GS bn
(8) BLUE total
(9) RED total

1. Variable Name: YARTY (i, j)

Size: (8, 7)

2. Array Specifications:

a. General Description and Usage: The array YARTY contains the effectiveness factors for artillery in the engagement. For fully effective artillery, the value is 1.0. A value of less than 1.0 is caused by a shortfall in crew personnel and/or ammunition.

b. Data Entry Definitions:

i = (1-8) Artillery tube type

j = (1) On line BLUE brigade DS bn

(2) BLUE reserve brigade DS bn

(3) BLUE division GS bn

(4) RED division DS bn

(5) RED division GS bn

(6) BLUE non-division GS bn

(7) RED non-division GS bn

1. Variable Name: AMMO (i)

Size: (88)

2. Array Specifications:

a. General Description of Usage: The array AMMO contains the TOE load for each weapon and tube type. This array is used in the attrition calculations in determining number of rounds fired by each weapon at each target type.

b. Data Entry Definition:

i = (1-26) BLUE direct fire weapons
(27-44) BLUE indirect fire weapons
(45-70) RED direct fire weapons
(71-88) RED indirect fire weapons

1. Variable Name: SUMWPN (i, j, k)
Size: (22, 2, 3)

2. Array Specifications:

a. General Description and Usage: The array SUMWPN contains the sum of the weapon type (i) on side (j) in the engagement. These values are computed in STAMAT for maneuver units and MATSUM for artillery and close air support.

b. Data Entry Definition:

i = (1-13) Weapon type in maneuver units
(14-21) Artillery cannon type
(22) Aircraft in CAS role

j = (1-2) Side (1 = BLUE, 2 = RED)

k = (1) Count of all weapons
(2) Count of weapons which are 100% effective using
ammo type 1
(3) Count of weapons which are 100% effective using
ammo type 2

1. Variable Name: AMOSTO (i, j, k)

Size: (2, 22, 2)

2. Array Specifications:

a. General Description and Usage: The array AMOSTO contains the count of rounds by type (i), by weapon type (j), and side (k). This value is computed in ASSESS for the maneuver units and CB for artillery and CAS.

b. Data Entry Definitions:

i = (1-2) Ammo type

j = (1-13) Maneuver unit weapon type

(14-21) Artillery cannon type

(22) CAS

k = (1-2) Side (1 = BLUE, 2 = RED)

1. Variable Name: P (i, j)

Size: (88, 22)

2. Array Specifications:

a. General Description and Usage: The array P contains the probability that a direct fire weapon j will hit a target j. For artillery weapons, the array contains the kills per round of the cannon against a target j. For direct fire weapons shooting, the values are computed in PHASE 1 preprocessor. The values for indirect fire weapons are computed in the assessment phase of the main model.

b. Data Entry Definition:

i = (1-44) BLUE weapon type 1 tube 1, . . .
BLUE CAS ammo type 2

(45-88) RED weapon type 1 tube 1, . . .
RED CAS ammo type 2.

j = (1-22) Target type

1. Variable Name: CONAMO (i, j)

Size: (2, 7)

2. Array Specifications:

a. General Description and Usage: The array CONAMO contains the fraction of the required artillery ammunition by type available to each type artillery battalion during an engagement. It is used to determine ammunition expended by each battalion during the engagement.

b. Data Entry Definitions:

i = (1-2) Type of artillery ammunition

j = (1-7) Artillery unit (1 = BLUE Brigade DS; 2 = Reserve BLUE Brigade DS; 3 = BLUE Division GS; 4 = RED DS; 5 = RED Division GS; 6 = BLUE non-division GS; 7 = RED non-division GS).

1. Variable Name: LETH (i, j, k)

Size: (9, 2, 44)

2. Array Specifications:

a. General Description and Usage: The array LETH contains the lethal area for each indirect fire weapon by round type against each type of target. These values are used in the assessment phase to determine combat losses caused by artillery cannons and close air support.

b. Data Entry Definition:

i = (1-8)	Cannon type
(9)	Close Air Support
j = (1-2)	Round type
k = (1-22)	BLUE target type
(23-44)	RED target type

Appendix B

MODIFIED CARD INPUT FORMATS

<u>CARD DESCRIPTION</u>	<u>PAGE</u>
Artillery Tube Description (IFP)	B-2
Arty DS Ammo Requirements	B-3
Arty GS Firepower and Ammo Expenditure	B-4
Artillery Battalion Type	B-5

Artillery Tube Description (IFP) Card (K/V)

FORMAT 2A4, 2X, 2F5.0, 52X, A3, 15

Col 1-8 "ARTYIFPS"

Col 9-10 Blank

Col 11-15 Meeting engagement IFP for ammo type 1

Col 16-20 Meeting engagement IFP for ammo type 2

Col 21-72 Blank

Col 73-75 Sequence label

Col 76-80 Sequence number

Note: Three cards are required for each artillery type. The first card contains AT IFPs, the second card has ALA IFPs, and the third card has the AP IFPs.

Arty DS Ammo Requirements Card (K/V)

FORMAT 2A4, 2X, 2F5.0, 52X, A3, I5

Col 1-8	"ARTYDSEX"
Col 9-10	blank
Col 11-15	Stowed load, type 1 ammo
Col 16-20	Stowed load, type 2 ammo
Col 21-72	blank
Col 73-75	Sequence label
Col 76-80	Sequence number

Arty GS Firepower and Ammo Expenditure Card (K/V)

FORMAT 2A4, 2X, 5F5.0, 37X, A3, I5

Col 1-8	"ARTYGSEX"
Col 9-10	blank
Col 11-15	GS AT IFP against reserves
Col 16-20	GS ALA IFP against reserves
Col 21-25	GS AP IFP against reserves
Col 26-30	Type 1 ammo expended against reserves
Col 31-35	Type 2 ammo expended against reserves
Col 36-72	blank
Col 73-75	Sequence label
Col 76-80	Sequence number

Arty Bn Type Card (K/V)
(one card required for each artillery bn type)

FORMAT 2A4, 2X, 9F5.0, 17X, A3, I5

Col 1-8	"ARTYBNTTP"
Col 9-10	blank
Col 11-15	Total cannon crew personnel authorized for the arty bn
Col 16-20	Total rounds of type 1 arty ammo in the arty bn
Col 21-25	Tube type X in arty bn
Col 26-30	Quantity of tube type X in arty bn
Col 31-35	Tube type Y in arty bn
Col 36-40	Quantity of tube type Y in arty bn
Col 41-45	Tube type Z in arty bn
Col 46-50	Quantity of tube type Z in arty bn
Col 51-55	Total rounds type 2 arty ammo in the arty bn
Col 56-72	Optional comments
Col 73-75	Sequence label
Col 76-80	Sequence number

Appendix C

Sample Output from a CEM Battle Engagement

SIPR MATR		ENGAGEMENT EXPENDITURE ATTRIBUTION										W L A P O N S	
SIPR TYPE	TIME TYPE	A M P O		W F A P O N S		SIPR REF		A M P O		W L A P O N S			
		ROUNDS/WPN/TIME	ON-HAND	TOTAL	ENGAGED	HIT	WPN TYPE	TUBE TYPE	ROUNDS/WPN/TIME	ON-HAND	TOTAL	ENGAGED	HIT
1	1	15.00	.00	.00	.00	.00	1	1	10.00	.00	.00	.00	.00
	2	100.00	.00	.00	.00	.00		2	100.00	.00	.00		
2	1	20.00	.00	.00	.00	.00	2	1	15.00	15.00	2.75	254.00	17.18
	2	150.00	.00	.00	.00	.00		2	100.00	100.00	361.91		
3	1	20.00	20.00	5.10	67.50	66.45	3	1	15.00	.00	.00	.00	.00
	2	100.00	100.00	84.90				2	100.00	.00	.00		
4	1	15.00	.00	.00	.00	.00	4	1	15.00	.00	.00	.00	.00
	2	50.00	.00	.00	.00	.00		2	190.00	.00	.00		
5	1	15.00	15.00	3.77	71.50	70.38	5	1	20.00	20.00	321.01	229.00	23.17
	2	100.00	100.00	212.68				2	100.00	100.00	1.03		
6	1	50.00	50.00	.71	26.55	26.14	6	1	15.00	.00	.00	.00	.00
	2	100.00	100.00	37.31				2	100.00	.00	.00		
7	1	10.00	10.00	1.30	8.50	8.37	7	1	10.00	10.00	.00	6.00	1.41
	2	100.00	100.00	.52				2	100.00	100.00	30.95		
8	1	15.00	.00	.00	.00	.00	8	1	.00	.00	.00	.00	.00
	2	100.00	.00	.00	.00	.00		2	.00	.00	.00		
9	1	20.00	.00	.00	.00	.00	9	1	.00	.00	.00	.00	.00
	2	100.00	.00	.00	.00	.00		2	.00	.00	.00		
10	1	15.00	15.00	.47	5.63	5.54	10	1	20.00	20.00	34.94	54.00	10.30
	2	50.00	50.00	.00				2	200.00	200.00	.00		
11	1	55.00	55.00	2.54	11.40	11.22	11	1	30.00	30.00	19.53	12.00	2.39
	2	100.00	100.00	.00				2	300.00	300.00	.00		
12	1	25.00	25.00	4.16	38.37	37.77	12	1	40.00	.00	.00	.00	.00
	2	100.00	100.00	.00				2	400.00	.00	.00		
13	1	.00	.00	.00	1056.63	487.62	13	1	.00	.00	.00	7721.00	37.61
	2	.00	.00	.04				2	.00	.00	.08		
14	1	50.00	50.00	.00	.00	.00	14	1	100.00	2.24	122.97	54.00	40.33
	2	200.00	200.00	.00				2	125.00	118.81	2764.82		
15	1	100.00	2.72	62.28	27.90	22.54	15	1	50.00	8.58	45.87	19.50	14.74
	2	300.00	300.00	577.77				2	25.01	23.77	459.30		
16	1	500.00	11.51	161.00	13.99	11.77	16	1	25.00	1.78	141.12	96.11	58.61
	2	300.00	300.00	1743.66				2	50.00	47.52	1413.09		

17	1	100.00	3.82	19.63	5.19	5.10	17	1	100.00	11.99	25.93	5.51	4.17
	2	300.00	100.00	125.12				2	300.00	285.14	259.67		
18	1	.00	.00	.00	.00	.00	18	1	25.00	3.00	112.67	37.59	28.43
	2	.00	.00	.00				2	35.00	33.27	373.53		
19	1	.00	.00	.00	.00	.00	19	1	200.00	23.98	132.20	5.51	4.17
	2	.00	.00	.00				2	300.00	285.14	439.00		
20	1	.00	.00	.00	.00	.00	20	1	4.77	.57	.86	1.50	1.14
	2	.00	.00	.00				2	8.06	7.66	2.85		
21	1	.00	.00	.00	.00	.00	21	1	1.58	.26	1.11	4.00	3.02
	2	.00	.00	.00				2	2.67	2.54	2.16		
22	1	500.00	500.00	7341.32	29.78	.84	22	1	200.00	200.00	*****	68.43	12.64
	2	300.00	300.00	7341.34				2	300.00	300.00	578.17		

DATE
FILMED
- 8